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Myxomycetes of Chihuahua (México) 4. Central plains of the Chihuahuan desert

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Abstract—Collections of myxomycetes gathered in field and cultivated in moist chamber cultures from samples collected in 10 localities in the central plains of the Chihuahuan desert were studied. Of the 37 species identified, eight (*Badhamia spinispora, B. verrucospora, Comatricha ellae, Didymium tehuacanense, Echinostelium paucifilum, Lycogala exiguum, Physarum apiculosporum*, and *P. spectabile*) represent new records for Chihuahua. *Badhamia verrucospora, Echinostelium paucifilum*, and *Physarum apiculosporum* are recorded for the first time from Mexico.

Key words—*Amoebozoa*, chorology, myxobiota, *Myxomycota*, SEM, slime moulds, taxonomy

Introduction

With a total area of 507,000 km^2, the Chihuahuan desert is the largest in North America and extends from New Mexico and Texas in the United States to north of Oaxaca in Mexico. It ranges in elevation between 1000–2000 m and has an annual average temperature of 16–18°C. Temperatures lower than 0°C have been recorded in some northern regions during winter. In summer, the most important precipitation occurs in the form of monsoons, although not exceeding 400 mm annually.

The vegetation of the Chihuahuan desert consists mainly of microphyllous scrubs, with *Larrea tridentata* (DC.) Coville (*Zygophyllaceae*), *Fouquieria*

Table 1. Studied localities and vegetation types

Locality	Latitude N	Longitude W	Elevation	Vegetation
Town Juárez 1. Samalayuca	31°13′53.1″	106°30′36.8″	1120 m	SDV
Town Ascensión 2. Ascención	31°36′36.0″	106°47′03.0″	1300 m	SDV
Town Guadalupe 3. El Cuervo	31°07′54.7″	105°42′47.8″	1100 m	MDS
Town Ahumada 4. Candelaria	31°07′32.0″	106°29′48.0″	1280 m	MDS
Town Ojinaga 5. La Mula	29°14′24.0″	104°26′09.0″	1380 m	MDS
6. Puente Pegüis II	29°32′28.9″	104°42′51.7″	770 m	MDS
Town Manuel Benavides 7. Camino a San Antonio, km 2	29°05′39.1″	103°52′38.0″	1065 m	MDS
Town Delicias 8. Parque Industrial	28°06′27.2″	105°24′53.9″	1160 m	MDS
Town Camargo 9. Carret. a Ojinaga Km 42	27°51′07.1″	104°44′04.7″	1265 m	MDS
Town Jiménez 10. Establo El Parral	27°24′53.3″	104°53′37.2″	1370 m	MDS

Vegetation: MDS = microphyllous desert scrub; SDV = sandy desert vegetation

splendens Engelm. (*Fouquieriaceae*), *Prosopis glandulosa* Torr. (*Leguminosae*), and several species of *Yucca* and *Agave* (*Asparagaceae*) among the main dominants. Especially prominent are a great diversity of small and medium-sized cacti (*Cactaceae*), including species of *Coryphantha, Cylindropuntia*, *Echinocereus*, *Mammillaria*, and *Opuntia* (Rzedowski 2006).

Despite its considerable biological diversity, only a few studies of its myxobiota have been conducted, most of which have focused on pine-oak forest ecosystems (Lizárraga et al. 2004a, 2005a,b, 2006; Moreno et al. 2006a,b; Salazar-Márquez et al. 2013). Other works on similar desert areas have been carried out mostly in central and southern Mexico (Mosquera et al. 2003, Lado et al. 2007, Wrigley de Basanta et al. 2008, Estrada-Torres et al. 2009). In contrast, few references exist for microphyllous desert scrub (Lizárraga et al. 2003, 2005a,b; Salazar-Márquez et al. 2014) for the more northern Chihuahuan desert.

During the past decade, the catalog of myxomycetes of the Chihuahua has been increased from 119 (Lizárraga et al. 2015) to 127 taxa (125 species and 2 varieties) due to research by Moreno et al. (2007), Lizárraga et al. (2015), and Salazar-Márquez et al. (2013, 2014).

Materials & methods

The survey was carried out in the central plains of the Chihuahuan desert. Ten localities with two types of vegetation were sampled seasonally from spring to winter 2009 (Table 1); each sampling effort took a week. The studied specimens were collected in the field or obtained in moist chamber cultures. Specimens are deposited in the collection of fungi of the Universidad Estatal de Sonora, Hermosillo, Mexico (UES), with a duplicate of some samples conserved in the herbarium of the Life Sciences Department (Botany), University of Alcalá, Madrid, Spain (AH). Permanent slides were prepared with Hoyer's liquid for microscopic study. Collectors names are abbreviated as follows: A. Gutiérrez (AG), M. Lizárraga (ML), D. López (DL), D. Sáenz (DS), C. Salazar (CS), and A. Sánchez (AS).

Spores (including surface structures such as spines or warts) were measured with an oil immersion lens. Light microscopy (LM) was carried out with a Nikon microscope equipped with an automatic photographic system. SEM micrographs were produced with a Zeiss DSM-950 microscope. For ultramicroscopic studies, material was rehydrated in concentrated (28–30%) ammonium hydroxide for 30 min, dehydrated in aqueous ethanol (70%) for 30 min, fixed for 2 h in pure ethylene glycol dimethyl ether (= 1,2–dimethoxymethane), and finally immersed in pure acetone for at least 2 h. This was followed by critical point drying and sputtering with gold-palladium. This technique allows the use of very little material (i.e., part of a single sporocarp or sometimes no more than a few spores).

Taxonomy

Arcyria cinerea (Bull.) Pers., Syn. Meth. Fung.: 184 (1801).

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, *Yucca elata* Engelm., 24 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 12 August 2009 (UES 8250); rat dung, 23 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8380); Loc. 3, *Tamarix chinensis* Lour. (*Tamaricaceae*), 20 May 2009, leg. ML, CS & DL, obtained from moist chamber 30 June 2009 (UES 7977); Loc. 6, *Agave lecheguilla* Torr., 23 March 2009, leg. ML & CS, obtained from moist chamber 20 April 2009 (UES 7561); *Euphorbia antisyphilitica* Zucc. (*Euphorbiaceae*), 25 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 7974); obtained from moist chamber 3 June 2009 (UES 7975, AH 45575). Loc. 10, rabbit dung, 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 5 August 2009 (UES 8255).

Observations — *Arcyria cinerea* was obtained in moist chamber on different substrates such as rat and rabbit dung. Its coprophilous habit has been noted by Eliasson & Lundqvist (1979), Eliasson & Keller (1999), and Krug et al. (2004). Previously cited for Chihuahua by Lizárraga et al. (2003).

Arcyria denudata (L.) Wettst., Verarb. Pilzfl. Steiermark 1: 9 (1885).

Specimen examined: **MEXICO, Chihuahua:** Loc. 6, *Yucca* sp. 23 March 2009, leg. ML & CS (UES 7562, AH 45576).

Observations — Previously cited for Chihuahua by Lizárraga et al. (2003).

Badhamia affinis Rostaf., Sluzowce Monogr.: 143 (1874).

Specimen examined: **MEXICO, Chihuahua:** Loc. 7, *Prosopis glandulosa*, 26 July 2009, leg. ML, CS, AG, DL & DS (UES 8262, AH 45577).

Observations — See Moreno & Oltra (2010) for a detailed study of *Badhamia affinis,* including photomicrographs of the spore ornamentation.

Badhamia gracilis (T. Macbr.) T. Macbr., Myxomycetes: 35 (1934).

Diagnostic characters include dark polygonal (12–14 µm diam.) warted spores and a badhamioid capillitium.

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, rabbit dung, 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 30 June 2009 (UES 8085); rat dung, obtained from moist chamber 30 June 2009 (UES 8087); Loc. 2, *Yucca elata*, 7 February 2009, leg. ML, CS & DS (UES 7690); obtained from moist chamber 25 February 2009 (UES 7691); 22 May 2009, leg. ML, CS & DL (UES 7982); rat dung, obtained from moist chamber 19 March 2009 (UES 7688); cow dung, 23 July 2009, leg. ML, CS, DL, AG & DS, obtained from moist chamber 8 September 2009 (UES 8362); Loc. 3, *Opuntia macrocentra* Engelm., 20 May 2009, leg. ML, CS & DL (UES 7978, 7979, 7980); 23 July 2009, leg. ML, CS, DL, DS & AG (UES 8266); obtained from moist chamber 3 August 2009 (UES 8268); obtained from moist chamber 8 August 2009 (UES 8267); obtained from moist chamber 10 August 2009 (UES 8220); obtained from moist chamber 12 August 2009 (UES 8239); Loc. 4, *Opuntia macrocentra*, 14 February 2009, leg. ML, CS & DS (UES 7694); obtained from moist chamber 26 February 2009 (UES 7695); obtained from moist chamber 2 March 2009 (UES 7696); Loc. 5, *Opuntia* sp., 25 May 2009, leg. ML, CS & DL, obtained from moist chamber (UES 7992); 25 October 2009, leg. ML, CS, AS, AG & DL (UES 8379); obtained from moist chamber 6 November 2009 (UES 8384); obtained from moist chamber 14 November 2009 (UES 8385); obtained from moist chamber 27 November 2009 (UES 8386, 8387); Loc. 6, *Yucca* sp., 23 March 2009, leg. ML & CS, obtained from moist chamber 20 April 2009 (UES 7706, 7707); *Agave lecheguilla*, 25 May 2009, leg. ML, CS & DL (UES 7988); Loc. 7, *Echinocereus enneacanthus* Engelm., 22 March 2009, leg. ML & CS, obtained from moist chamber 14 April 2009 (UES 7702); *Yucca* sp., obtained from moist chamber 20 April 2009 (UES 7703); Loc. 8, *Opuntia* sp., 23 March 2009, leg. ML & CS, obtained from moist chamber 13 April 2009 (UES 7709); Loc. 9, *Opuntia macrocentra,* 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 22 August 2009 (UES 8313); obtained from moist chamber 29 August 2009 (UES 8316, AH 45578).

Observations — *Badhamia gracilis,* which is succulenticolous, has been the most abundant species in both the field and moist chamber cultures in most studied localities. We cite only a limited number of samples for each locality, but much more material was deposited in the herbarium. Study of the spore ornamentation under SEM by Moreno & Oltra (2010) demonstrated the morphological separation of this species from *Badhamia melanospora* Speg.

Badhamia gracilis was reported on dung by Krug et al. (2004); in this study, it was observed in rabbit, rat and cow dung.

Previously cited for Chihuahua by Lizárraga et al. (2003) and Salazar-Márquez et al. (2014).

****Badhamia spinispora*** (Eliasson & N. Lundq.) H.W. Keller & Schokn.,
Mycologia 81: 632 (1989). Figs 1, 2

Fructifications sessile subglobose sporocarps to short plasmodiocarps, white to grayish, growing solitary or grouped. Capillitium varying from physaroid to badhamioid, consisting of irregular filaments and calcareous nodules. Spores black in mass, light violaceous under LM, globose, subglobose to oval, 10–12 µm diam., ornamented by obvious spines.

Specimens examined: MEXICO, Chihuahua: Loc. 1, rat dung, 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 25 June 2009 (UES 7994); Loc. 2, cow dung, 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8361, AH 45555).

Observations — *Badhamia spinispora* is a rare species, generally with a coprophilous habit. The differences between it and *Badhamia verrucospora* and *Physarum apiculosporum* are detailed in the observations under those species.

Previously cited for Sonora by Esqueda et al. (2013).

*****Badhamia verrucospora*** G. Moreno, D.W. Mitch. & Novozh., Bol. Soc. Micol.
Madrid 35: 98 (2011). Figs 3, 4

Fructifications subglobose sporocarps to short plasmodiocarps, in groups, white, sessile, 0.2–0.5 × 0.2–1 mm. Peridium double, calcareous, with irregular dehiscence. Capillitium scarce, consisting of filaments connected by irregular calcareous nodules. Spores (15–)17–18 × 10–12 µm diam., black in mass, purple under LM, subglobose to oval, a broad part of its surface is ornamented with clearly marked warts, the rest of the spore has a thinner wall and smaller warts, sometimes with ornamentation almost lacking.

Specimens examined: MEXICO, Chihuahua: Loc. 1, cow dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 7 March 2009 (UES 7644, AH 45556); 24 July 2009, leg. ML, CS, DL, DS & AG (UES 8269); obtained from moist chamber 25 August 2009 (UES 8370); obtained from moist chamber 1 September 2009 (UES 8317); obtained from moist chamber 8 September 2009 (UES 8371); Loc. 2, cow dung, 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 9 March 2009 (UES 7641); obtained from moist chamber 18 March 2009 (UES 7642, AH 45578); obtained from moist chamber 31 March 2009 (UES 7643); rabbit dung, obtained from moist chamber 1 September 2009 (UES 8318); 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8517, 8518); rabbit dung, 23 July

2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 September 2009 (UES 8365); Loc. 3, cow dung, 23 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 September 2009 (UES 8376); Loc. 4, cow dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 26 March 2009 (UES 7645); Loc. 5, horse dung, 24 May 2009, leg. ML, CS & DL, obtained from moist chamber 30 June 2009 (UES 7995); Loc. 7, cow dung, 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8530).

OBSERVATIONS — *Badhamia spinispora* (Eliasson & Lundqvist 1979; as *Physarum spinisporum*), is morphologically similar to *P. apiculosporum* and *B. verrucospora*. It is characterized by its globose to broadly oval spores with sharp spines, while *P. apiculosporum* has oval to ellipsoidal spores that are smooth and with two apiculi. *Badhamia verrucospora* spores are similar to those of *Physarum apiculosporum* (oval to ellipsoid with two apiculi) but ornamented by abundant small warts over half the spore surface (Moreno et al. 2011). *Badhamia rhytidosperma* H.W. Keller & Schokn., which resembles the three previous species but with reticulate spores, has not yet been reported from Mexico, according to the consulted literature.

Comatricha elegans (Racib.) G. Lister, Guide Brit. Mycetozoa, 3rd Ed.: 31 (1909).
FIGS 9–11

Sporocarps small (0.5–1 mm tall); columella branched; stipe fibrous; the capillitium forming an external link with well-defined more or less continuous meshes; spores 9–10 µm diam., warted.

SPECIMEN EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 3, *Tamarix chinensis*, 20 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8065, AH 45557).

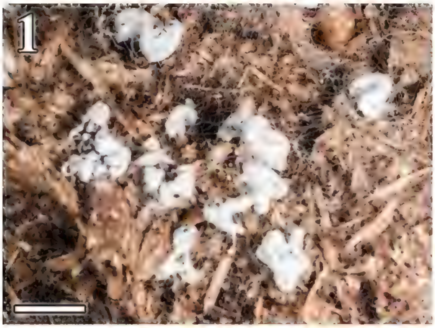
OBSERVATIONS — A SEM study of *Comatricha elegans* was carried out by Lizárraga et al. (2005a).

Poorly known in Mexico (Moreno et al. 2007), *C. elegans* has been previously recorded for Chihuahua by Lizárraga et al. (2005b) and Salazar-Márquez et al. (2014).

Comatricha ellae Härk., Karstenia 18: 23 (1978). FIG. 12

Sporocarps small (0.5–1 mm tall); sporotheca 0.2–0.4 mm diam.; capillitium with well-defined meshes mostly into stipe junction; columella percurrent, spores 9–10 µm diam.

FIGS 1–8. ***Badhamia spinispora*** (AH 45555). 1. Plasmodiocarps. 2. Spore spinulose (SEM). ***Badhamia verrucospora*** (AH 45556). 3. Plasmodiocarps. 4. Spore verrucose (SEM). ***Fuligo cinerea*** (AH 45574). 5. Plasmodiocarps. 6. Spore reticulate (SEM). ***Physarum apiculosporum*** (AH 45566). 7. Plasmodiocarps. 8. Spore smooth (SEM). Scale bars: 1, 3, 5, 7 = 1 mm; 2, 4, 6, 8 = 2 µm.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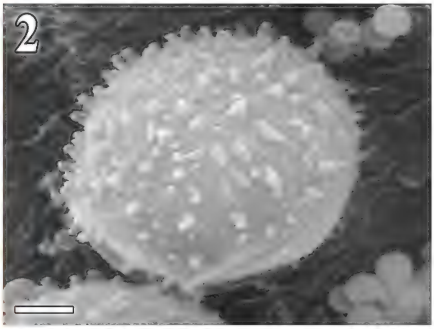
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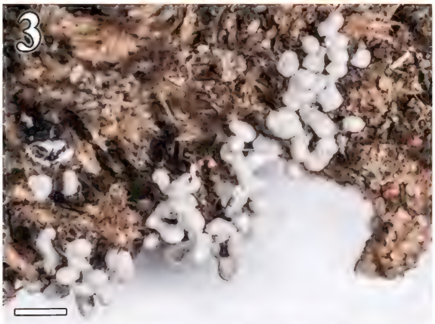
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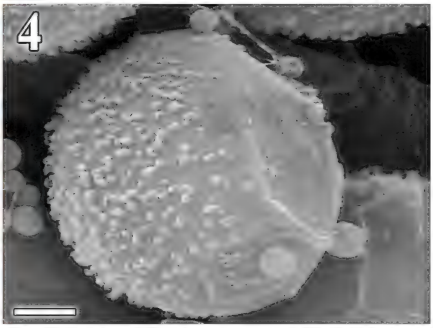
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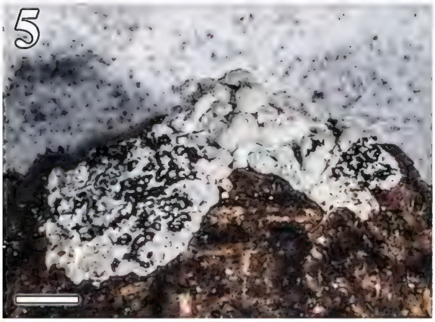
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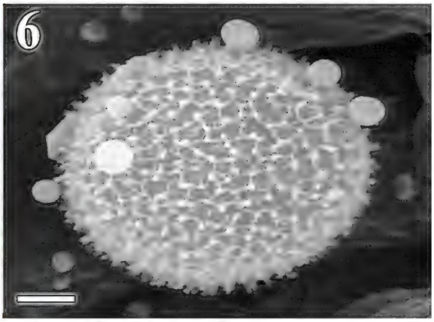
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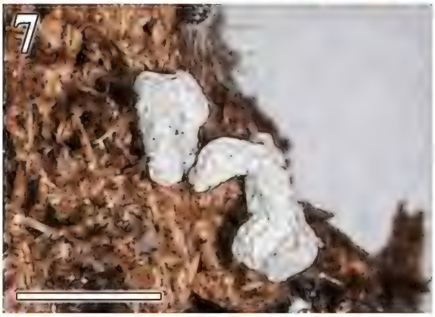
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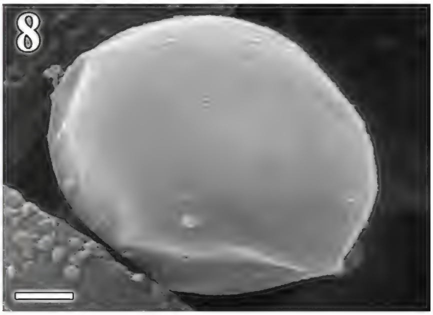
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Specimen examined: **MEXICO, Chihuahua:** Loc. 1, *Artemisia filifolia* Torr. (*Asteraceae*), 24 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 5 August 2009 (UES 8307, AH 45558).

Observations — We observed this species frequently in moist chamber cultures on succulent plant crusts.

Comatricha ellae was cited previously only from Baja California Sur (Moreno et al. (2007).

Comatricha tenerrima (M.A. Curtis) G. Lister, Guide Brit. Mycetozoa, 4th Ed.: 39 (1919).

Characterized by the acuminate sporothecal apex, sinuous capillitium, and spores light violaceous under LM and 8–9 µm diam., warted.

Specimens examined: **MEXICO, Chihuahua:** Loc. 10, *Cylindropuntia* sp., 21 March 2009, leg. ML & CS, obtained from moist chamber 6 April 2009 (UES 7742, AH 45579); *Koeberlinia spinosa* Zucc. (*Koeberliniaceae*), 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 10 August 2009 (UES 8229).

Observations —Salazar-Márquez et al. (2014) reported that SEM photographs show that the spore ornamentation in *C. tenerrima* is formed by joined bacula with a characteristic star-shaped morphology.

Previously cited for Chihuahua by Salazar-Márquez et al. (2014) and Lizárraga et al. (2005b).

Dictydiaethalium plumbeum (Schumach.) Rostaf. ex Lister, Monogr. Mycetozoa: 157 (1894).

Cultures in moist chambers showing considerable morphological variation; aethalia small (0.5–1 mm diam.), subglobose to pulvinate.

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, *Prosopis glandulosa,* 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 3 June 2009 (UES 8010); Loc. 3, *Larrea tridentata,* 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 5 February 2009 (UES 7570); obtained from moist chamber 13 February 2009 (UES 7571); 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 27 November 2009 (UES 8424); obtained from moist chamber 9 December 2009 (UES 8425); Loc. 4, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 28 February 2009 (UES 7572); obtained from moist chamber 1 April 2009 (UES 7573, AH 45580); Loc. 7, *Porlieria angustifolia* (Engelm.) A. Gray (*Zygophyllaceae*), 22 March 2009, leg. ML & CS, obtained from moist chamber 14 April 2009 (UES 7574); *Larrea tridentata*, 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 21 November 2009 (UES 8421); obtained from moist chamber 27 November 2009 (UES 8423); *Prosopis glandulosa,* obtained from moist chamber 21 November 2009

Figs 9–14. ***Comatricha elegans*** (AH 45557). 9. Sporocarp. 10. Capillitium detail forming an external net and columella. 11. Stalk fibrous. ***Comatricha ellae*** (AH 45558). 12. Sporocarp. ***Echinostelium arboreum*** (AH 45560). 13, 14. Sporocarp detail, peridium persistent, membranous, collar, columella, capillitium, and spores. Scale bars: 9–12 = 100 µm; 13, 14 = 10 µm.

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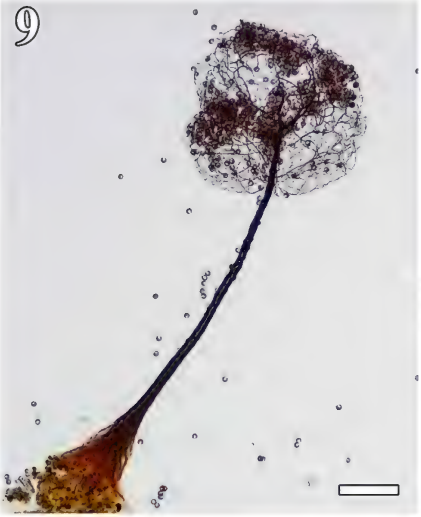

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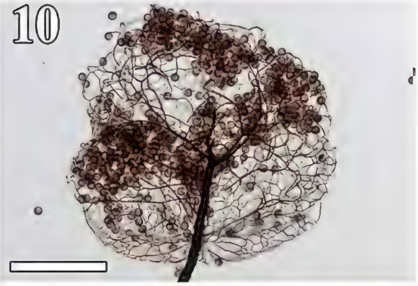

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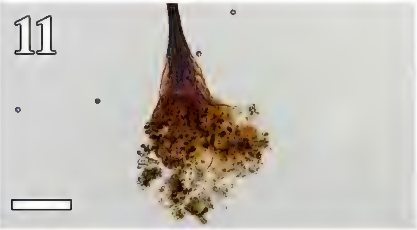

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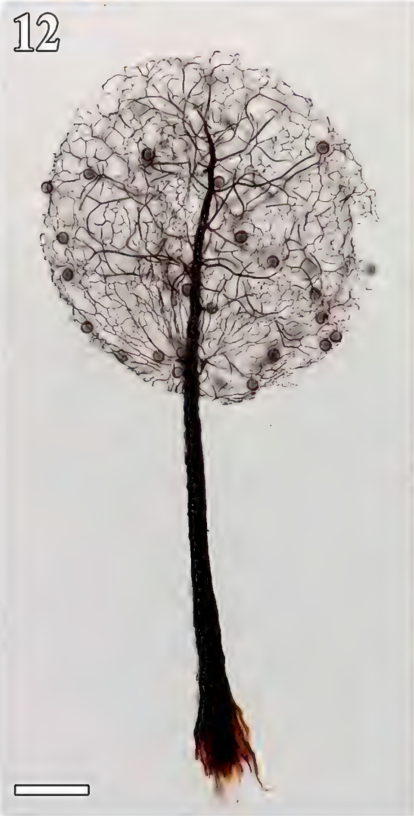

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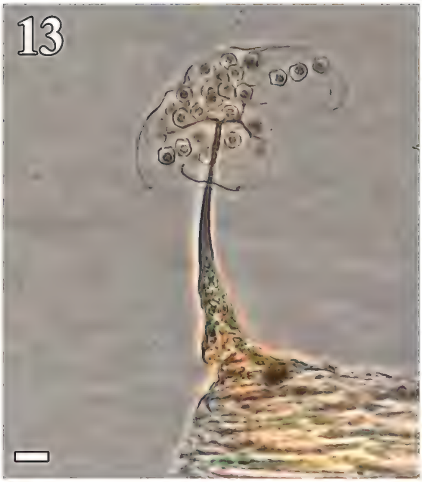

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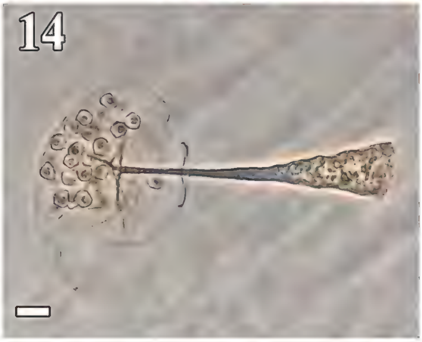


(UES 8422); Loc. 8, 23 March 2009, obtained from moist chamber 4 April 2009 (UES 7576); obtained from moist chamber 20 April 2009 (UES 7685); 24 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 November 2009 (UES 8417); obtained from moist chamber 21 November 2009 (UES 8418); Loc. 9, *Acacia greggii* A. Gray (*Leguminosae*), leg. ML & CS, obtained from moist chamber 10 August 2009 (UES 8224); *Larrea tridentata,* obtained from moist chamber 22 August 2009 (UES 8326); 25 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 14 December 2009 (UES 8415); obtained from moist chamber 9 December 2009 (UES 8416); Loc. 10, *Larrea tridentata,* 21 March 2009, obtained from moist chamber 8 April 2009 (UES 7575); *Prosopis glandulosa,* 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 3 June 2009 (UES 8009); *Larrea tridentata,* 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 August 2009 (UES 8287); obtained from moist chamber 12 August 2009 (UES 8254); obtained from moist chamber 15 August 2009 (UES 8325); 25 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 6 November 2009 (UES 8419); obtained from moist chamber 9 November 2009 (UES 8420); obtained from moist chamber 14 December 2009 (UES 8427); obtained from moist chamber, 21 November 2009 (UES 8489).

OBSERVATIONS — We follow the broad species concept of Martin & Alexopoulos (1969), which accepts a widely variable aethalium size and color.

Previously cited for Chihuahua by Lizárraga et al. (2005a).

Didymium difforme (Pers.) Gray, Nat. Arr. Brit. Pl. 1: 571 (1821).

Spores warted, 13–15 µm diam.; sporotheca pulvinate with a crust-like peridium.

SPECIMEN EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 4, rabbit dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 25 March 2009 (UES 7588).

OBSERVATIONS —Eliasson & Lundqvist (1979), Eliasson & Keller (1999) and Krug et al. (2004) reported this species from dung.

Didymium difforme is rarely cited from Mexico (Moreno et al. 2007). Previously reported for Chihuahua on rabbit dung (Salazar-Márquez et al. 2014).

Didymium dubium Rostaf., Sluzowce Monogr.: 143 (1874).

SPECIMENS EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 1, *Prosopis glandulosa,* 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 24 February 2009 (UES 7787); obtained from moist chamber 28 February 2009 (UES 7788, 7789, 7790); *Artemisia filifolia,* 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 26 February 2009 (UES 7782); cow dung, obtained from moist chamber 26 February 2009 (UES 7783); obtained from moist chamber 28 February 2009 (UES 7784); obtained from moist chamber 31 March 2009 (UES 7785); rabbit dung, obtained from moist chamber 18 March 2009 (UES 7786); *Yucca* sp., 24 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 12 August 2009 (UES 8334); Loc. 2, *Artemisia filifolia,* 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 16 February 2009 (UES 7763); *Yucca elata,* obtained from moist chamber 16 February 2009 (UES 7776);

Prosopis glandulosa, 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 21 February 2009 (UES 7767); rabbit dung, obtained from moist chamber 27 February 2009 (UES 7764); obtained from moist chamber 14 March 2009 (UES 7765); 23 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 10 August 2009 (UES 8221); Loc. 3, *Prosopis glandulosa*, obtained from moist chamber 10 February 2009 (UES 7754); *Larrea tridentata*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 3 February 2009 (UES 7745); *Tamarix chinensis*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 23 February 2009 (UES 7761); *Fouquieria splendens*, 20 May 2009, leg. ML, CS & DL, obtained from moist chamber 3 June 2009 (UES 8011); Loc. 4, *Fouquieria splendens*, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 21 February 2009 (UES 7777); *Prosopis glandulosa*, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 2 March 2009 (UES 7770); *Yucca elata*, obtained from moist chamber 3 June 2009 (UES 8020); *Larrea tridentata*, 24 February 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 10 August 2009 (UES 8223); Loc. 5, *Fouquieria splendens*, 22 March 2009, obtained from moist chamber 4 April 2009 (UES 7796); *Cylindropuntia imbricata* (Haw.) F.M. Knuth, 24 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8032); *Prosopis glandulosa*, obtained from moist chamber 29 May 2009 (UES 8034); Loc. 6, *Prosopis glandulosa*, 23 March 2009, leg. ML & CS, obtained from moist chamber 4 April 2009 (UES 7806); *Fouquieria splendens*, obtained from moist chamber 6 April 2009 (UES 7804); *Agave lecheguilla*, 26 October 2009, disposed in moist chamber 2.XI.20009, fructifications 14 December 2009 (UES 8462); Loc. 7, *Agave lecheguilla*, 22 March 2009, leg. ML & CS, obtained from moist chamber 13 April 2009 (UES 7800); *Prosopis glandulosa*, 26.VII.09, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 August 2009 (UES 8284); *Larrea tridentata*, obtained from moist chamber 21 November 2009 (UES 8447); *Cylindropuntia imbricata*, obtained from moist chamber 12 August 2009 (UES 8245); Loc. 9, *Prosopis glandulosa*, 22 March 2009, leg. ML & CS, obtained from moist chamber 6 April 2009 (UES 7795); rabbit dung, 22 July 2009, leg. ML, CS, DL, AS & AG, obtained from moist chamber 15 August 2009 (UES 8335); Loc. 10, rabbit dung, 21 March 2009, leg. ML & CS, sporocarps obtained 13 April 2009 (UES 7794); *Acacia constricta* A. Gray (*Leguminosae*), 23 May 2009, leg. ML, CS & DL, obtained from moist chamber 3 June 2009 (UES 8025).

Observations — *Didymium dubium* exhibits great morphological variation in the sporocarps but can be recognized by spores 12–14 µm diam., with small bacula that form a characteristic reticle easily visible under SEM (Moreno et al. 2001). It was frequently collected in the studied area; thus, only samples of different localities and habitats are cited.

Previously recorded for Chihuahua by Lizárraga et al. (2003) and Salazar-Márquez et al. (2014).

Didymium mexicanum G. Moreno, Lizárraga & Illana, II Int. Congr. Syst. Ecol. Myxomycetes: 56 (1996).

= *Didymium umbilicatum* D. Wrigley, Lado & Estrada, Mycologia 100: 922 (2008).

Specimens examined: **MEXICO, Chihuahua:** Loc. 6, *Yucca* sp., 23 March 2009, leg. ML & CS (UES 7577); leg. ML, CS, DL, DS & AG, obtained from moist chamber 22 August 2009 (UES 8337); 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 November 2009 (UES 8455); *Agave lecheguilla,* obtained from moist chamber 27 November 2009 (UES 7578, 7579, 7580), obtained from moist chamber 4 April 2009 (UES 7581); obtained from moist chamber 10 April 2009 (UES 7582); obtained from moist chamber 14 April 2009 (UES 7802); obtained from moist chamber 20 April 2009 (UES 7803, 7812); obtained from moist chamber 1 May 2009 (UES 7583); 25 May 2009, leg. ML, CS & DL (UES 8027, 8028); obtained from moist chamber 25 June 2009 (UES 8030); obtained from moist chamber 30 June 2009 (UES 8031); 26 July 2009, leg. ML, CS, DL, DS & AG (UES 8286); 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 27 November 2009 (UES 8459); obtained from moist chamber 18 December 2009 (UES 8463, 8465); obtained from moist chamber 5 January 2010 (UES 8466).

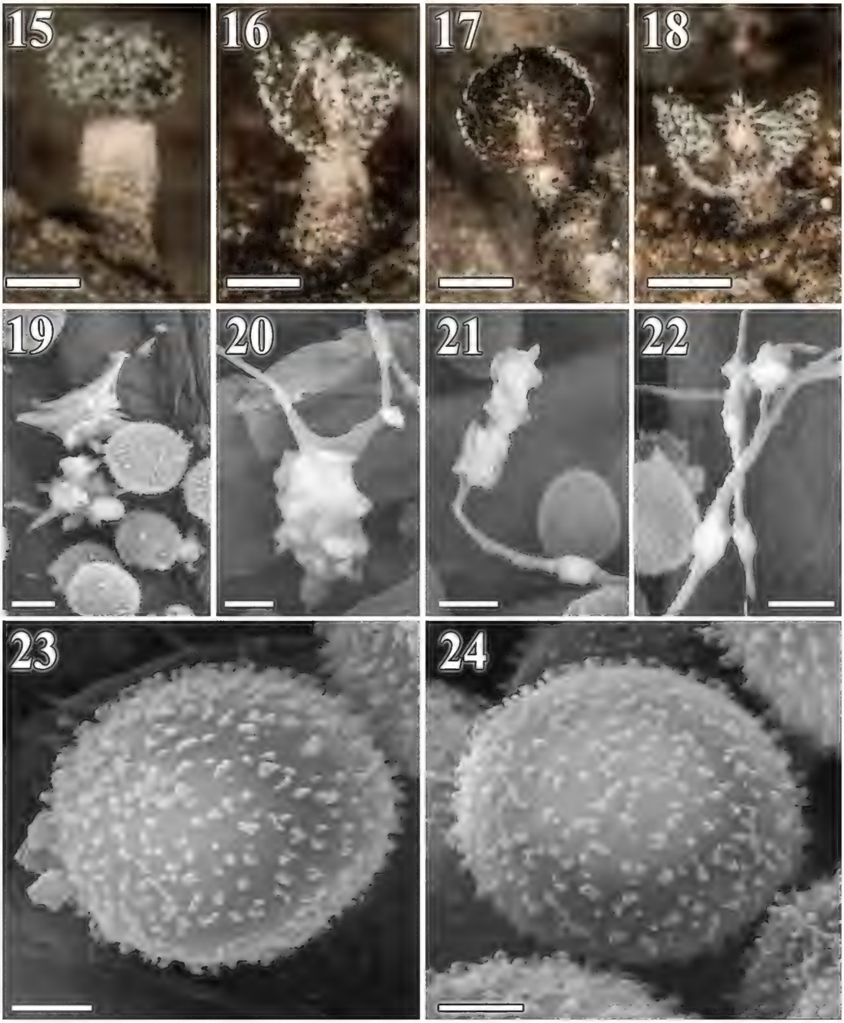
OBSERVATIONS — Moreno et al. (2012) included samples from Chihuahua in their recent macro- and microscopical (including SEM) examinations of *Didymium mexicanum* and *D. umbilicatum* that confirmed these species are synonyms.

In Mexico, this species is known from Baja California (Moreno et al. 1997, 2012; Lizárraga et al. 2004b), Chihuahua (Moreno et al. 2012; Salazar-Márquez et al. 2014), Hidalgo (Wrigley de Basanta et al. 2008, as *D. umbilicatum*), Oaxaca (Wrigley de Basanta et al. 2008, as *D. umbilicatum*; Estrada-Torres et al. 2009, as *D. umbilicatum*), Puebla (Wrigley de Basanta et al. 2008, as *D. umbilicatum*; Estrada-Torres et al. 2009, as *D. umbilicatum*), and Querétaro (Wrigley de Basanta et al. 2008, as *D. umbilicatum*). It has also been cited from Argentina (Lado et al. 2011), Guatemala (Wrigley de Basanta et al. 2008, as *D. umbilicatum*), and Russia (Novozhilov et al. 2006). It has been collected from Spain (Murcia), Kazakhstan (West Kazakhstan region), and United States (Arizona and New Mexico) (Discover Life 2014).

Didymium squamulosum (Alb. & Schwein.) Fr., Symb. Gasteromyc. 3: 19 (1818).

SPECIMENS EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 3, *Larrea tridentata,* 24 January 2009, leg. ML, CS, DS, obtained from moist chamber 25 March 2009 (UES 7585); 20 May 2009, leg. ML, CS & DL, obtained from moist chamber 15 June 2009 (UES 8038, AH 45583); obtained from moist chamber 25 June 2009 (UES 8040); obtained from moist chamber 30 June 2009 (UES 8039, AH 45584); *Larrea tridentata,* 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 27 November 2009 (UES 8440); obtained from moist chamber 9 December 2009 (UES 8441); Loc. 4, *Yucca elata,* 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 18 March 2009 (UES 7586, AH 45582); 20 March 2009 (UES 7813); Loc. 6, *Yucca* sp., 23 March 2009, leg. ML & CS, obtained from moist chamber 20 April 2009 (UES 7686, AH 45581); Loc. 9, *Xanthium* sp. (*Asteraceae*), 22 March 2009, obtained from moist chamber 20 April 2009 (UES 7687).

OBSERVATIONS — *Didymium squamulosum* is a cosmopolitan species (Martin & Alexopoulos 1969). Previously cited for Chihuahua by Lizárraga et al. (2003) and Salazar-Márquez et al. (2014).



FIGS 15–24. ***Didymium tehuacanense*** (AH 45559). 15. Sporocarp. 16. Peridium simple and fragile. 17, 18. Columella detail: cylindrical, calcareous, whitish, with ramified and spinose apex. 19. Peridium with starry crystals. 20–22. Capillitium filamentous with abundant nodules (SEM). 23, 24. Spore (SEM). Scale bars. 15–18 = 0.25 mm; 19–22 = 5 µm; 23, 24 = 2 µm.

******Didymium tehuacanense*** Estrada, D. Wrigley & Lado, Fungal Diversity 36: 32 (2009). FIGS 15–24

Fructifications stipitate, gregarious, 0.5–1 mm height (FIG. 15). Sporotheca globose to subglobose of 0.3–0.5 mm diam. Peridium simple, iridescent to grayish, membranous, fragile, persistent on the base of the sporotheca like a collar and covered by starry crystals of whitish calcium carbonate, of bigger size than spores (7–22 µm diam.) Stipe 0.3–0.5 × 0.2–0.4 mm, cylindrical, calcareous, whitish to dark according to the presence of calcium carbonate, wider and darker at the base. Columella 0.2 × 0.1 mm, prominent, calcareous, cylindrical, whitish, with the apex branched and spiny. Hypothallus discoid, membranous. Capillitium formed by thin filaments of 1 µm diam., with thickening or nodules. Spores 8–10 µm diam., dark in mass, violaceous under LM, with a paler area, ornamented with thick warts. Spore ornamentation is formed by irregularly distributed bacula that occasionally join to form short crests as can be seen under SEM.

Specimens examined: **MEXICO, Chihuahua:** Loc. 6, *Agave lecheguilla,* next to *Didymium mexicanum*, 23 March 2009, leg. ML & CS (UES 7577); 25 May 2009, leg. ML, CS & DL (UES 8036); 26 July 2009, leg. ML, CS, DL, DS & AG (UES 8285, AH 45559).

Observations — *Didymium tehuacanense* is characterized by a calcareous stipe and columella, cylindrical columella with a ramified apex and a capillitium with calcareous thickenings.

The above specimens represent a new record for Chihuahua. Previously cited from Oaxaca and Puebla (Estrada-Torres et al. 2009), where it was described as a species new to science.

Echinostelium apitectum K.D. Whitney, Mycologia 72: 954 (1980).

Fructifications stalked, 190–230 µm tall; body spore-like, globose. Stalk 120–210 µm long, filled with granular matter, tapered. Spores 9–11 µm diam., subglobose, uniform wall, hyaline, smooth to weakly warted.

Specimens examined: **MEXICO, Chihuahua:** Loc. 3, *Artemisia filifolia,* 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 16 February 2009 (UES 7822); Loc. 7, *Prosopis glandulosa*, 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 August 2009 (UES 8297); *Chilopsis linearis* (Cav.) Sweet (*Bignoniaceae*), 24 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8050).

Observations — *Echinostelium apitectum* can be confused with fructifications of *E. colliculosum*, which differs by its spores with articulated surfaces and smaller (70–150 µm tall) fructifications (Whitney 1980; Lado & Pando 1997).

Infrequently collected in Mexico, *E. apitectum* is reported for Baja California, Chihuahua, Sonora, and Tlaxcala (Moreno et al. 2007).

Echinostelium arboreum H.W. Keller & T.E. Brooks, Mycologia 68: 1207 (1977)
Figs 13, 14

Peridium persistent, membranous, with a collar; sporotheca 40–50 µm diam.; columella cylindrical ≤25 µm tall, without a spore-like body; capillitium well developed in our sample, dichotomously branched, not anastomosed. Spores 7–8 µm diam., globose to subglobose, hyaline, smooth to rough and without articulated surfaces.

Specimen examined: **MEXICO, Chihuahua:** Loc. 2, *Artemisia filifolia,* 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 14 November 2009 (UES 8471, AH 45560).

Observations —*Echinostelium arboreum* is known from Baja California, Chihuahua, and Yucatán (Moreno et al. 2007).

Echinostelium colliculosum K.D. Whitney & H.W. Keller, Mycologia 72: 641 (1980).

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, *Artemisia filifolia,* 23 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 6 November 2009 (UES 8481); cow dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 28 February 2009 (UES 7839); *Prosopis glandulosa*, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 24 February 2009 (UES 7830); *Artemisia filifolia,* 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 19 February 2009 (UES 7828); Loc. 2, *Artemisia filifolia,* 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 13 February 2009 (UES 7821); *Prosopis glandulosa*, 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 16 February 2009 (UES 7823); *Yucca elata,* 23 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 3 August 2009 (UES 8288); Loc. 3, *Prosopis glandulosa*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 5 February 2009 (UES 7834); *Larrea tridentata*, obtained from moist chamber 6 November 2009 (UES 8477); *Prosopis glandulosa*, obtained from moist chamber 4 February 2009 (UES 7836. *Koeberlinia spinosa,* 20 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8041); Loc. 4, *Prosopis glandulosa*, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 24 January 2009 (UES 7824); cow dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 5 March 2009 (UES 7837); *Yucca elata,* obtained from moist chamber 23 February 2009 (UES 7827); *Larrea tridentata,* obtained from moist chamber 26 February 2009 (UES 7838); Loc. 5, *Prosopis glandulosa*, 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 29 May 2009 (UES 8051); *Larrea tridentata,* obtained from moist chamber 8 August 2009 (UES 8293); *Cylindropuntia imbricata*, obtained from moist chamber 10 August 2009 (UES 8218); Loc. 6, *Viguiera stenoloba* S.F.Blake (*Asteraceae*), 23 March 2009, leg. ML & CS, obtained from moist chamber 4 April 2009 (UES 7843); Loc. 7, *Acacia greggii,* 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 3 August 2009 (UES 8296); *Cylindropuntia imbricata*, 22 March 2009, leg. ML & CS, obtained from moist chamber 4 April 2009 (UES 7840); *Porlieria angustifolia,* obtained from moist chamber 4 April 2009 (UES 7841); *Viguiera stenoloba,* obtained from moist chamber 4 April 2009 (UES 7842); 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 6 November 2009 (UES 8484); Loc. 8, *Larrea tridentata*, next to *Dictydiaethalium plumbeum*, 23 March 2009, leg., ML & CS, obtained from moist chamber 4 April 2009 (UES 7576); 24 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 November 2009 (UES 8473); *Porlieria angustifolia,* 23 March 2009, leg. ML & CS, obtained from moist chamber 4 April 2009 (UES 7844); *Viguiera stenoloba* obtained from moist chamber 6 April 2009 (UES 7831); *Yucca* sp., 24 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 6 November

2009 (UES 8472); obtained from moist chamber 9 November 2009 (UES 8474); Loc. 9, *Prosopis glandulosa*, 25 July 2009, obtained from moist chamber 8 August 2009 (UES 8291); *Acacia greggii,* obtained from moist chamber 10 August 2009 (UES 8231); Loc. 10, *Acacia greggii,* 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8046); *Larrea tridentata*, 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 August 2009 (UES 8292).

Observations — *Echinostelium colliculosum* is very difficult to distinguish from *E. coelocephalum* T.E. Brooks & H.W. Keller, since both develop stalked fructifications with a spore-like body on the stipe apex and have globose spores with articulated surfaces. We can differentiate them, because *E. coelocephalum* forms small fructifications 40–70 µm height and very thickened articulated surfaces, while *E. colliculosum* presents larger fructifications of 70–150 µm, and less thickened articulated surfaces (see Whitney 1980).

Echinostelium colliculosum has not been reported as coprophilous by Eliasson & Lundqvist (1979), Eliasson & Keller (1999), or Krug et al. (2004).

Previously cited from Chihuahua by Lizárraga et al. (2003) and Salazar-Márquez et al. (2014).

*****Echinostelium paucifilum*** K.D. Whitney, Mycologia 72: 974 (1980). Figs 25–27

Sporocarps dispersed to gregarious, pinkish brown, stalked, 200–330 µm tall. Stalk 150–210 µm long, filled with granular matter, wider at base with 5–6 µm diam., reducing gradually until the apex to 2–3 µm diam. Peridium fleeting, persisting at base like a collar *ca.* 4 µm diam. Columella cylindrical. Capillitium rudimentary or barely developed. Spores 10–12 µm diam., free, globose to subglobose, hyaline, warted, with one or several protoplasts.

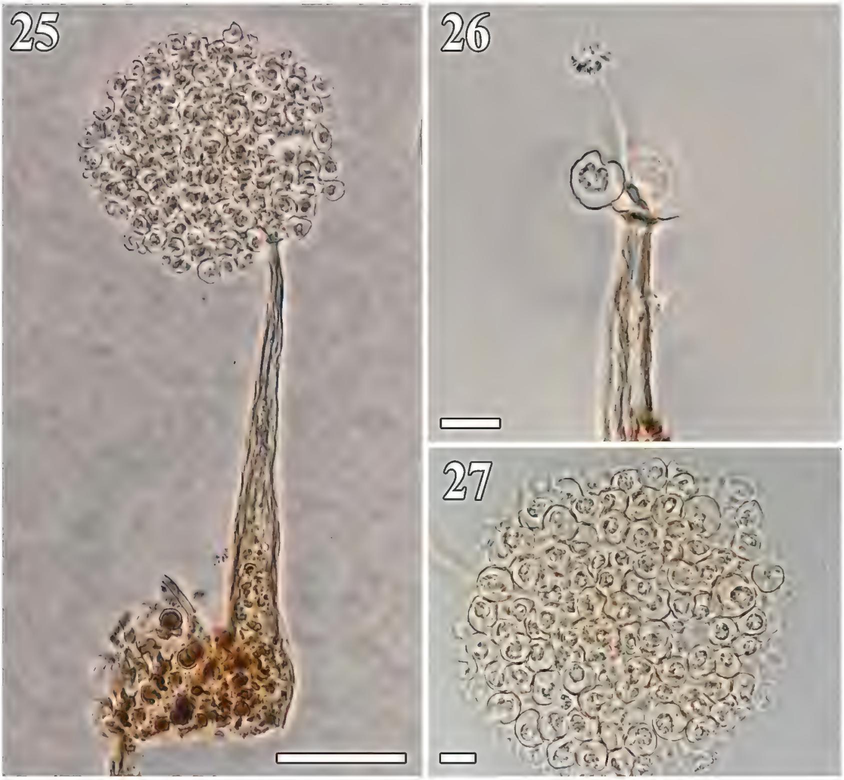
Specimens examined: MEXICO, Chihuahua: Loc. 3, *Artemisia filifolia*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 27 January 2009, 16 February 2009 (UES 7822); Loc. 8, *Acacia constricta,* 23 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8044, 8045, AH 45561).

Observations — *Echinostelium paucifilum* is similar to *E. minutum* de Bary, which differs in its larger sporocarps (250–500 µm) and smaller spores (6–8 µm) with articulated surfaces (Whitney 1980).

These collections are new records for Mexico and the Neotropics (Lado & Wrigley de Basanta 2008).

Fuligo cinerea (Schwein.) Morgan, J. Cincinnati Soc. Nat. Hist. 19: 33 (1896). Figs 5, 6

Specimens examined: MEXICO, Chihuahua: Loc. 2, cow dung, 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 11 June 2009 (UES 8053, AH 45599); Loc. 4, rabbit dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 27



Figs 25–27. ***Echinostelium paucifilum*** (AH 45561). 25. Sporocarp. 26. Spores. 27. Collar, columella and spore. Scale bars. 25= 50 µm; 26, 27 = 10 µm.

March 2009 (UES 7589, AH 45574); Loc. 7, above ground, 26 October 2009, leg. ML, CS, AS, AG & DL (UES 8486).

Observations — *Fuligo cinerea* generally fruited on herbivore dung following cultivation in moist chamber; macroscopically confused with *Badhamia verrucospora*, *B. spinispora*, and *Physarum apiculosporum* but distinguished from those three species by its spores that are oval to subglobose, warted, and subtly reticulated (Fig. 6). Small fructifications that are convoluted or gyrose on dung could resemble *Physarum gyrosum* Rostaf., but the characteristic *F. cinerea* spores clearly identify it, as noted by Eliasson & Lundqvist (1979) from collections from Tenerife (Canary Islands, Spain) on rabbit dung. We have collected them on rabbit and cow dung.

Previously cited for Chihuahua by Lizárraga et al. (2003) and Salazar-Márquez et al. (2014).

Fuligo septica (L.) F.H. Wigg., Prim. Fl. Holsat.: 112 (1780).

Fructifications showed a whitish aethalium which coincides with *Fuligo septica* var. *candida* (Pers.) R.E. Fr.; spores globose to subglobose with thin warts, 9–11 µm diam., slightly larger than the size (7–9 µm) cited in the literature.

Specimen examined: **MEXICO, Chihuahua:** Loc. 7, above-ground, 26 October 2009, leg. ML, CS, AS, AG & DL (UES 8486, AH 45565).

Observations — This species is widely distributed in Mexico (Moreno et al. 2007).

Licea biforis Morgan, J. Cincinnati Soc. Nat. Hist. 15: 131 (1893).

Sporocarps large, sessile, yellowish brown to dark brown, with a longitudinal centerline dehiscence; spores globose to subglobose, yellow in mass, subtly warted, 10–11 µm diam.

Specimens examined: **MEXICO, Chihuahua:** Loc. 3, *Tamarix chinensis,* 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 5 February 2009 (UES 7596, AH 45597); *Acacia greggii,* obtained from moist chamber 12 August 2009 (UES 8242); *Prosopis glandulosa*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 26 February 2009 (UES 7602); Loc. 6, *Viguiera stenoloba,* 23 March 2009, obtained from moist chamber 20 April 2009 (UES 7610); Loc. 7, *Porlieria angustifolia,* 22 March 2009, obtained from moist chamber 13 April 2009 (UES 7606); *Acacia greggii,* obtained from moist chamber 8 August 2009 (UES 8300); Loc. 10, *Cylindropuntia* sp., 21 March 2009, leg. ML & CS, obtained from moist chamber 8 April 2009 (UES 7603, 7604); *Larrea tridentata,* obtained from moist chamber 8 April 2009 (UES 7605).

Observations — *Licea biforis* has been cultivated in moist chambers over different tree barks and bushes, including succulent desert plants such as members of the *Cactaceae* and *Liliaceae.*

Two species have been described with a succulenticolous habit similar to *Licea biforis: Licea succulenticola* (Mosquera et al. 2003) and *Licea capacia* Oltra & G. Moreno (Moreno & Oltra 2014).

Licea biforis has been previously cited for Chihuahua and Sonora (Moreno et al. 2007).

Licea denudescens H.W. Keller & T.E. Brooks, Mycologia 69: 668 (1977).

Specimens examined: **MEXICO, Chihuahua:** Loc. 2, 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 13 March 2009 (UES 7614); obtained from moist chamber 23 February 2009 (UES 7717); 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8338); Loc. 3, *Prosopis glandulosa,* 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 16 February 2009 (UES 7612); obtained from moist chamber 23 February 2009 (UES 7718); obtained from moist chamber 28 February 2009 (UES 7613, AH 45596); 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 21 November 2009 (UES 8488); obtained from moist chamber 27 November 2009 (UES 8502); obtained from moist chamber 9 December 2009 (UES 8503); Loc. 7, *Acacia greggii,* 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 29 August 2009 (UES 8340); 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8500); *Chilopsis linearis,* 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 29 August 2009 (UES 8341); *Fouquieria splendens,* 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 27 November 2009 (UES 8498); *Cylindropuntia* sp., obtained from moist chamber 9 December 2009 (UES 8501).

Observations — Recently described for Chihuahua by Salazar-Márquez et al. (2014), and previously from Puebla (Estrada-Torres et al. 2009) and Sonora (Esqueda et al. 2013).

Licea kleistobolus G.W. Martin, Mycologia 34: 702 (1942).

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 25 February 2009 (UES 7617); obtained from moist chamber 26 February 2009 (UES 7619); obtained from moist chamber 27 February 2009 (UES 7618); obtained from moist chamber 2 March 2009 (UES 7621, AH 45595); obtained from moist chamber 12 March 2009 (UES 7620); 23 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 5 August 2009 (UES 8302); obtained from moist chamber 8 August 2009 (UES 8303); *Prosopis glandulosa*, obtained from moist chamber 8 August 2009 (UES 8304); Loc. 2, *Artemisia filifolia,* 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 12 February 2009 (UES 7616); obtained from moist chamber 16 February 2009 (UES 7714); Loc. 3, *Prosopis glandulosa*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 22 February 2009 (UES 7615); 23 July 2009, leg. ML, CS & DL, DS & AG, obtained from moist chamber 8 August 2009 (UES 8301); Ibidem, *Tamarix chinensis,* 25 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 21 November 2009 (UES 8495); Loc. 6, *Viguiera stenoloba,* 25 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8058); *Yucca* sp., 26 July 2009, obtained from moist chamber 22 August 2009 (UES 8345); Loc. 9, *Acacia greggii*, 25.X.20009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 14 November 2009 (UES 8493); obtained from moist chamber 21 November 2009 (UES 8494); Loc. 10, *Larrea tridentata*, 25 October 2009, obtained from moist chamber 21 November 2009 (UES 8496).

Observations — Previously cited from Chihuahua by Lizárraga et al. (2003) and Salazar-Márquez et al. (2014).

Licea succulenticola Mosquera, Lado, Estrada & Beltrán-Tej., Anales Jard. Bot. Madrid 60: 4 (2003).

Specimens examined: **MEXICO, Chihuahua:** Loc. 6, *Agave lecheguilla,* 23 March 2009, leg. ML & CS (UES 7622, AH 45594; UES 7638 next to *Perichaena vermicularis*).

Observations — Recently described from Chihuahua by Salazar-Márquez et al. (2014). It might be widely distributed in Mexico but has been unobserved because of its small size.

Lycogala exiguum Morgan, J. Cincinnati Soc. Nat. Hist. 15: 134 (1893).

Aethalium small (2–4 mm diam.); peridium ornamented by outgoing reddish brown warts which form a compartmented structure that gives a false pluricellular appearance under LM; spores 5–6 µm diam.; capillitium abundant, 2–10 µm diam., filamentous, tubular, with sinuous walls.

Specimen examined: MEXICO, Chihuahua: Loc. 6, *Yucca* sp., 23 March 2009, leg. ML & CS (UES 7623, AH 45593).

Observations — See Hooff (2014) for diagnostic differences among species of *Lycogala* Adans.

Lycogala exiguum has been reported for Jalisco, Nuevo León, Quintana Roo, Tabasco, Veracruz, and Yucatán (Moreno et al. 2007).

Perichaena pachyderma D.W. Mitch., G. Moreno & Lizárraga, Bol. Soc. Micol. Madrid 35: 104 (2011). Figs 28–33

Fructifications sessile, globose to subglobose, solitary to gregarious. Sporotheca 0.1–0.3 mm diam., dark yellow in youth, to dark brown when maturing. Peridium simple, 3–4.5 µm thick, externally covered by granular matter; the internal surface presents small warts which binding with a reticulated appearance (not noted by Mitchell et al. (2011) in his type description). Capillitium not observed. Spores 10–11 µm diam., orange-yellow in mass, light yellow under LM, globose, subtly spinulose. Spore ornamentation is formed by irregular distributed bacula.

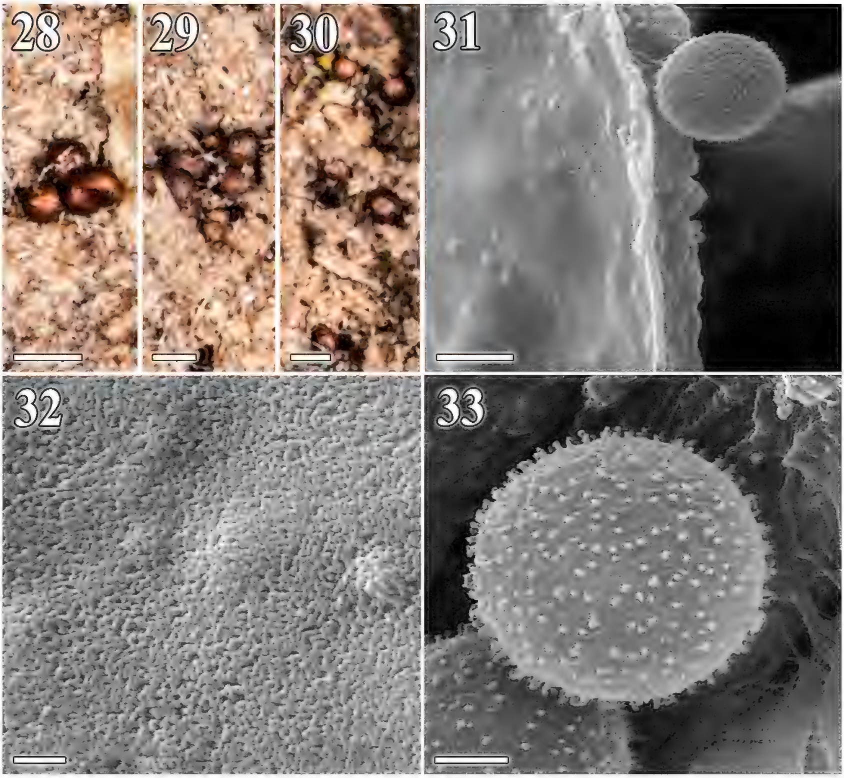
Specimens examined: MEXICO, Chihuahua: Loc. 3, cow dung, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 13 February 2009 (UES 7591); obtained from moist chamber 17 February 2009 (UES 7592); Loc. 5, 23 March 2009, leg. ML & CS, obtained from moist chamber 6 April 2009 (UES 7594, AH 45562); Loc. 6, 23 March 2009, obtained from moist chamber 6 April 2009 (UES 7595); Loc. 9, 24 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8057).

Observations — Fructifications cultivated in moist chamber over herbivore dung were similar to *Licea tenera* E. Jahn (studied by Martin & Alexopoulos, 1969), but *L. tenera* has smooth spores and our collections have spinulose or verrucose ornamentation. The specimens also resemble *Perichaena* cf. *liceoides* Rostaf. as described by Eliasson & Lundqvist (1979) but which has a poorly developed capillitium, absent in our collections.

Although it is very possible that this coprophilous species has a wider distribution, it is only known from the United States (New Mexico) and Mexico (Baja California and Chihuahua) (Mitchell et al. 2011).

Perichaena quadrata T. Macbr., N. Amer. Slime-Moulds: 184 (1899). Figs 34–42

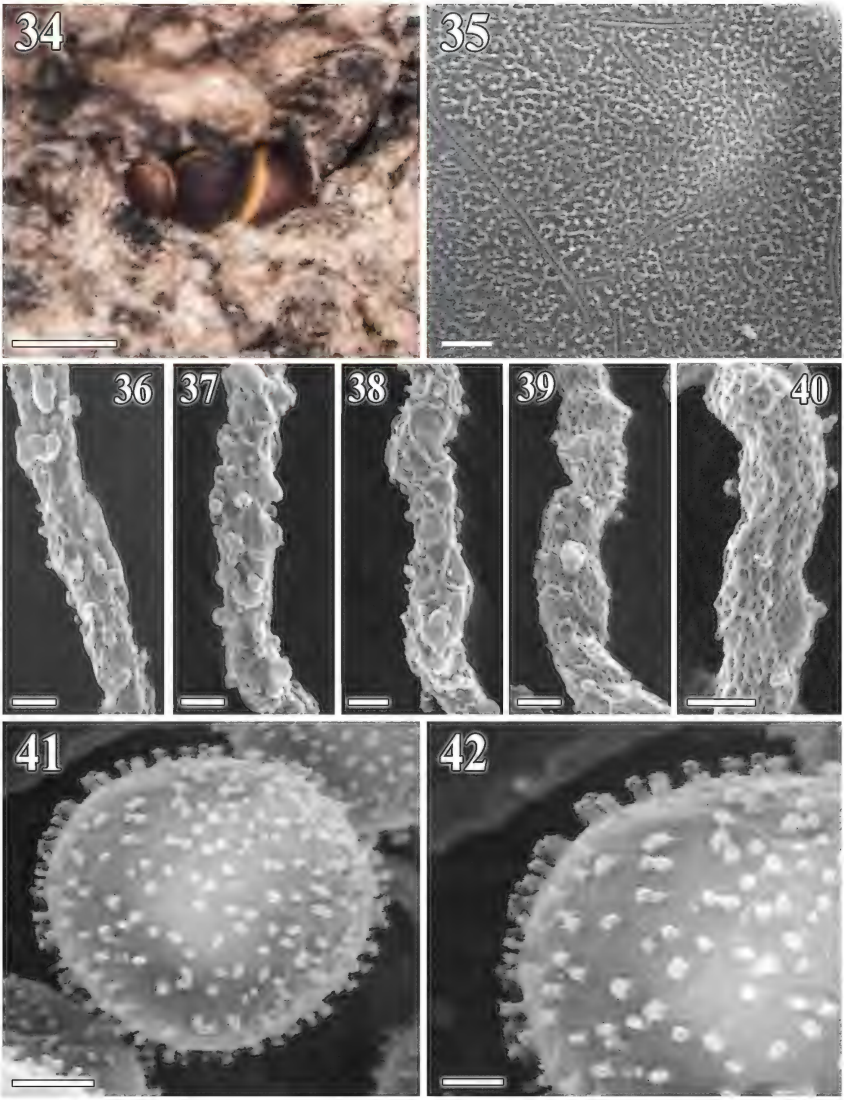
Fructifications gregarious (rarely solitary), rounded to pulvinate, convex, 0.3–0.5 cm diam., reddish brown to more or less blackish when maturing,



Figs 28–33. ***Perichaena pachyderma*** (AH 45562). 28–30. Sporocarps gregarious to solitary. 31. Peridium thick (SEM). 32. Peridium internal surface detail (SEM). 33. Spore (SEM). Scale bars: 28–31 = 0.1 mm; 31 = 5 µm; 32 = 1 µm; 33 = 2 µm.

dehiscence circumscissile and separating the peridium like a convex operculum. Peridium internal surface warted, with the warts joining to form sometimes anastomosing sinuous structures. Capillitium abundant, filiform, 1.5–2 µm diam.; under SEM, the ornamentation seen as thick isolated more or less abundant warts and a reticle full of variably wide meshes. Spores 9–11 µm diam., yellowish, spinulose (LM); under SEM, ornamentation is formed by uniformly distributed bacula and a weakly coralloid apex.

Specimens examined: MEXICO, Chihuahua: Loc. 2, *Yucca elata*, 7 February 2009, leg. ML, CS & DS (UES 7626); cow dung, 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 30 June 2009 (UES 8066); Loc. 4, *Tamarix chinensis*, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 25 March 2009 (UES 7627, AH 45563); Loc. 6, *Agave lecheguilla*, 26 October 2009, leg. ML, CS, AS, AG & DL (UES 8511, AH 45564); Loc. 8, *Yucca* sp., 25 July 2009, leg. ML, CS, AG, DL & DS, obtained from moist chamber 22 August 2009 (UES 8354).



Figs 34–42. ***Perichaena quadrata*** (AH 45563). 34. Sporocarps gregarious. 35. Peridium, internal surface detail (SEM). 36–40. Variable capillitium reticulate ornamentation (SEM). 41, 42. Spore ornamentation (SEM, detail). Scale bars: 34 = 1 mm; 35–40, 42 = 1 µm; 41 = 2 µm.

Observations — *Perichaena quadrata* has been confused or synonymized with *P. depressa* Lib., which presents larger sporocarps (0.5–1.2 cm diam.), also with a circumscissile peridium but flat apex; capillitium 2–2.5(–3) µm diam., filiform, and without a reticulated ornamentation, as observed by Keller & Eliasson (1992), whose concept we follow.

Rammeloo (1981) examined under the SEM two African species close to *P. quadrata* that fructify over different substrata: *P. areolata* Rammeloo (leaves), and *P. dictyonema* Rammeloo (crusts and wood debris); *P. dictyonema* is morphologically very similar to *P. quadrata*, and they might represent the same species.

Perichaena quadrata has been recorded from Puebla (Estrada-Torres et al. 2009) and Chihuahua (Lizárraga et al., 2015). It was cited as coprophilous by Eliasson & Lundqvist (1979), Eliasson & Keller (1999), and Krug et al. (2004). Previously cited from Chihuahua by Lizárraga et al. (2015).

*******Physarum apiculosporum*** Härk., Karstenia 18: 24 (1978). FIGS 7, 8

Plasmodiocarps gregarious, sessile, pulvinate, sinuous, curved or reticulated, 0.3–0.6 mm wide × 4.5 mm long. Peridium greyish to white, double, with the two layers closely associated, outer layer with abundant lime; inner layer thin, membranous. Dehiscence irregular. Capillitium formed by scarce thin filaments, white, rounded to angular lime nodes. Spores black in mass, reddish brown, 10–14 × 8–10 µm, ellipsoid to oval, smooth with an apiculus and a longitudinal ridge by LM; spore surface smooth under SEM.

SPECIMEN EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 7, cow dung, 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 December 2009 (UES 8530, AH 45566).

OBSERVATIONS — *Physarum apiculosporum* is characterized by forming plasmodiocarps and spores oval to ellipsoid, smooth, with two pointed ends, one at each ending (Härkönen 1978, Moreno et al. 2011). This species may be confused with *Badhamia verrucospora;* both share habit and spore ornamentation, but *B. verrucospora* differs in warted spores that are strongly marked over half of the surface, while the remainder is smooth, even under SEM (Moreno et al. 2011).

Physarum apiculosporum is a new record for Mexico and the Neotropics (Lado & Wrigley de Basanta 2008).

Physarum decipiens M.A. Curtis, Amer. J. Sci. Arts, Ser. 2, 6: 352 (1848).

SPECIMENS EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 1, *Prosopis glandulosa*, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 21 February 2009 (UES 7661); obtained from moist chamber 28 February 2009 (UES 7662); obtained from moist chamber 6 March 2009 (UES 7663); Loc. 2, 7 February 2009, leg. ML, CS & DS, obtained from moist chamber 14 March 2009 (UES 7659); Loc. 3, *Prosopis glandulosa*, 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 2 March 2009 (UES 7658); Loc.

4, *Larrea tridentata,* 14 February 2009, 16 February 2009, leg. ML, CS & DS, obtained from moist chamber 18 March 2009 (UES 7660); *Fouquieria splendens,* 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 10 August 2009 (UES 8236); Loc. 7, *Viguiera stenoloba,* 22 March 2009, leg. ML & CS, obtained from moist chamber 20 April 2009 (UES 7664); *Acacia greggii,* 24 May 2009, leg. ML, CS & DL, obtained from moist chamber 11 June 2009 (UES 8074); *Acacia greggii*, 26 July 2009, leg. ML, CS, DL, AG & DS, obtained from moist chamber 8 August 2009 (UES 8215); obtained from moist chamber 10 August 2009 (UES 8235); 26 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 6 November 2009 (UES 8515); obtained from moist chamber 27 November 2009 (UES 8529, AH 45592); Loc. 10, *Prosopis glandulosa*, 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 8 September 2009 (UES 8366, AH 45591).

Observations — *Physarum decipiens* is morphologically highly variable. Previously reported from Chihuahua (Lizárraga et al. 2003), Oaxaca, Puebla (Estrada-Torres et al. 2009), Sonora (Esqueda et al. 2013), and Tlaxcala (Rodríguez-Palma et al. 2002).

Physarum leucophaeum Fr., Symb. Gasteromyc. 3: 24 (1818).

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, cow dung, 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 14 March 2009 (UES 7665); rabbit dung, obtained from moist chamber 2 April 2009 (UES 7653, AH 45567); 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 22 June 2009 (UES 8092); Loc. 3, *Prosopis glandulosa*, 20 May 2009, leg. ML, CS & DL, obtained from moist chamber 25 June 2009 (UES 8091, AH 45568); Loc. 6, *Prosopis glandulosa*, 25 June 2009, obtained from moist chamber 3 June 2009 (UES 8080, AH 45590); Loc. 8, *Cylindropuntia imbricata*, 25 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 5 August 2009 (UES 8211).

Observations — *Physarum leucophaeum* is very close to *P. robustum* and *P. notabile* T. Macbr., two species that appear confused in the literature. We follow Nannenga-Bremekamp (1991) for distinguishing *P. leucophaeum* from *P. robustum: P. leucophaeum* presents a capillitium with very few calcium carbonate nodules, which are small and round, while *P. robustum* has a capillitium with bigger and abundant fusiform calcium carbonate nodules that generally join at sporotheca center to form a whitish pseudocolumella (see photographs in Poulain et al. 2011). Our specimens were collected on cow and rabbit dung. This coprophilous habit was not indicated in Eliasson & Lundqvist (1979), Eliasson & Keller (1999), and Krug et al. (2004). Previously cited from Chihuahua by Lizárraga et al. (2003).

Physarum pusillum (Berk. & M.A. Curtis) G. Lister, Monogr. Mycetozoa, 2nd Ed.: 64 (1911).

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, cow dung, obtained from moist chamber 30 June 2009 (UES 8086); Loc. 2, *Yucca elata,* 7 February 2009, leg. ML, CS

& DS, obtained from moist chamber 24 March 2009 (UES 7670); obtained from moist chamber 24 March 2009 (UES 7669); 23 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 15 August 2009 (UES 8360); Loc. 3, *Tamarix chinensis,* 24 January 2009, leg. ML, CS & DL, obtained from moist chamber 25 February 2009 (UES 7650); obtained from moist chamber 2 March 2009 (UES 7651); *Larrea tridentata*, obtained from moist chamber 3 March 2009 (UES 7646); *Koeberlinia spinosa,* 14 February 2009, leg. ML, CS & DS, obtained from moist chamber 30 June 2009 (UES 8081); Loc. 4, *Larrea tridentata,* leg. ML, CS & DS, obtained from moist chamber 18 March 2009 (UES 7652); Loc. 5, *Cylindropuntia imbricata*, 22 May 2009, obtained from moist chamber 11 June 2009 (UES 8073); Loc. 7, *Chilopsis linearis,* 24 May 2009, leg. ML, CS & DL, obtained from moist chamber 15 June 2009 (UES 8094); Loc. 8, *Opuntia* sp., 24 October 2009, leg. ML, CS, AS, AG & DL (UES 8378); inflorescence of *Yucca* sp., 23 May 2009, obtained from moist chamber 29 May 2009 (UES 8071); obtained from moist chamber 3 June 2009 (UES 8096, AH 45587); obtained from moist chamber 22 June 2009 (UES 8093); Loc. 10, *Koeberlinia spinosa,* 25 July 2009, obtained from moist chamber 22 August 2009 UES 8363); *Acacia constricta*, obtained from moist chamber 8 September 2009 (UES 8364).

OBSERVATIONS — *Physarum pusillum* is frequently observed in moist chamber cultures. Previously reported for Chihuahua by Lizárraga et al. (2003).

Physarum robustum (Lister) Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., C 76: 484 (1973).

SPECIMENS EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 4, *Tamarix chinensis,* 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 30 June 2009 (UES 8084, AH 45569); Loc. 6, *Prosopis glandulosa*, 26 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 10 August 2009 (UES 8234, AH 45570).

OBSERVATIONS — For *Physarum robustum* we follow the concept of Nannenga-Bremekamp (1991). Differences with closely related species like *P. album* (Bull.) Chevall., *P. leucophaeum*, and *P. leucopus* Link have been described for Sonora (Moreno et al. 2004) and Chihuahua (Lizárraga et al. 2015).

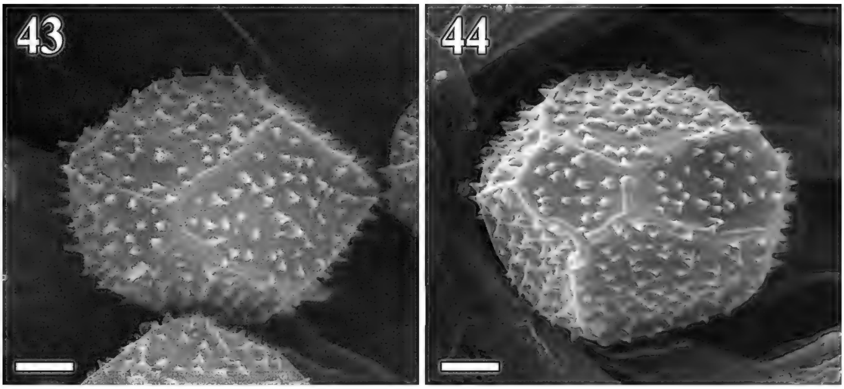
****Physarum spectabile*** Nann.-Bremek., Lado & G. Moreno, Proc. Kon. Ned. Akad. Wetensch., C 87: 91 (1984).

SPECIMENS EXAMINED: **MEXICO, CHIHUAHUA:** Loc. 6, *Agave lecheguilla,* 23 March 2009 (UES 7668); *Yucca* sp., 23 March 2009 (UES 7667, AH 45571).

OBSERVATIONS — *Physarum spectabile* is a common succulenticolous species. Recorded for Oaxaca and Puebla by Estrada-Torres et al. (2009)

Physarum straminipes Lister, J. Bot. 36: 163 (1898). FIGS 43, 44

Fructifications whitish, stipitate with a false stalk, which is an extension of a whitish to yellowish hypothallus; capillitium with whitish nodules, globose, more abundant at the center of the sporocarp; spores polygonal, dark, with scarce and thick spines of irregular distribution (see SEM).



Figs 43, 44. ***Physarum straminipes*** (AH 45572). Spores (SEM). Scale bars = 2 µm.

Specimen examined: **MEXICO, Chihuahua:** Loc. 9, rabbit dung, 22 March 2009, leg. ML & CS, obtained from moist chamber 1 May 2009 (UES 7671, AH 45572).

Observations — *Physarum straminipes* was not noted as coprophilous by Eliasson & Lundqvist (1979), Eliasson & Keller (1999), or Krug et al. (2004). Previously reported for Baja California, Sonora (Moreno et al. 2007), and Querétaro (Tapia et al. 2008).

Protophysarum phloiogenum M. Blackw. & Alexop., Mycologia 67: 33 (1975).

Specimens examined: **MEXICO, Chihuahua:** Loc. 1, *Atriplex canescens* (Pursh) Nutt. (*Amaranthaceae*), obtained from moist chamber 6 March 2009 (UES 7684); 24 July 2009, leg. ML, CS, DL, DS & AG, obtained from moist chamber 12 August 2009 (UES 8238); Loc. 3, *Tamarix chinensis,* 24 January 2009, leg. ML, CS & DS, obtained from moist chamber 3 February 2009 (UES 7673); obtained from moist chamber 4 February 2009 (UES 7674); obtained from moist chamber 5 February 2009 (UES 7675); obtained from moist chamber 11 February 2009 (UES 7676); *Atriplex canescens,* 22 October 2009, leg. ML, CS, AS, AG & DL, obtained from moist chamber 9 November 2009 (UES 8532); obtained from moist chamber 14 November 2009 (UES 8533); obtained from moist chamber 21 November 2009 (UES 8522); Loc. 4, *Atriplex canescens,* 14.II.2209, leg. ML, CS & DS, obtained from moist chamber 23 February 2009 (UES 7677); obtained from moist chamber 2 March 2009 (UES 7678); obtained from moist chamber 11 March 2009 (UES 7679); 22 May 2009, leg. ML, CS & DL, obtained from moist chamber 29 May 2009 (UES 8097); obtained from moist chamber 1 June 2009 (UES 8098); obtained from moist chamber 3 June 2009 (UES 8099); obtained from moist chamber 11 June 2009 (UES 8100); obtained from moist chamber 15 June 2009 (UES 8101); decomposing wood, obtained from moist chamber 3 June 2009 (UES 8102); *Yucca elata,* 14.II.2209, leg. ML, CS & DS, obtained from moist chamber 27 February 2009 (UES 7680); obtained from moist chamber 2 March 2009 (UES 7681); rabbit dung, obtained from moist chamber 20 March 2009 (UES 7682).

Observations — *Protophysarum phloiogenum* appears frequently on such substrates as *Atriplex canescens, Tamarix chinensis, Yucca elata*, and even on rabbit dung when cultured in moist chambers. A complete study of this species, including its variable spore ornamentation, was carried out by Castillo et al. (1998). Previously cited for Baja California, Chihuahua (Moreno et al. 2007), and Sonora (Esqueda et al. 2013).

Trichia agaves (G. Moreno, Lizárraga & Illana) Mosquera, Lado, Estrada & Beltrán-Tej., Cuad. Trab. Fl. Micol. Ibér. 16: 82 (2001).

Specimen examined: **MEXICO, Chihuahua:** Loc. 6, *Agave lecheguilla,* leg. ML, CS, DL, DS & AG, 26 July 2009 (UES 8214, AH 45573).

Observations — This species was described by Moreno et al. (2000) from several collections from Mexico and Spain on members of the *Cactaceae* and *Liliaceae*. It is frequently collected in desert areas and was recently reported for Cuba (Camino et al. 2008).

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